WHAT IS CLAIMED AS NEW AND DESIRED TO BE SECURED BY LETTERS PATENT OF THE UNITED STATES IS:

1. An arrayed waveguide grating optical multiplexer/demultiplexer comprising:

at least one first optical waveguide;

a first slab waveguide;

an arrayed waveguide connected to said at least one first optical waveguide via said first slab waveguide, said arrayed waveguide comprising a plurality of channel waveguides each of which has a different length;

a second slab waveguide;

a plurality of second optical waveguides connected to said arrayed waveguide via said second slab waveguide; and

at least one expanding width waveguide having a first end portion and a second end portion, a second width of the second end portion being larger than a first width of the first end portion, the first end portion of each of said at least one expanding width waveguide being connected to each of said at least one first optical waveguide, the second end portion being connected to said first slab waveguide, the first width of the first end portion being larger than a first optical waveguide width of said at least one first optical waveguide, the first width of said first end portion satisfying a single mode condition, a width of said at least one expanding width waveguide increasing from the first end portion toward the second end portion.

2. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 1, further comprising:

at least one straight waveguide each provided between each of said at least one first optical waveguide and each of said at least one expanding width waveguide, said at least one straight waveguide having a width narrower than the first optical waveguide width of said at

least one first optical waveguide.

3. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 1, further comprising:

at least one constant width waveguide provided between each of said at least one first optical waveguide and each of said at least one expanding width waveguide, said at least one constant width waveguide having a substantially constant width which is substantially equal to the first width of the first end portion of said at least one expanding width waveguide.

4. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 3, further comprising:

at least one straight waveguide provided between each of said at least one first optical waveguide and each of said at least one constant width waveguide, said at least one straight waveguide having a width narrower than the first optical waveguide width of said at least one first optical waveguide.

5. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 1, wherein the first width (w) of said first end portion satisfies the following expression,

$$w < \frac{3\lambda}{\pi\sqrt{n_1^{\,2} - n_0^{\,2}}} \quad \text{..... (Exp. 4)}$$

where (n_1) is refractive index of core, (n_0) is refractive index of cladding, and (λ) is a wavelength of light.

6. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 1, wherein said at least one expanding width waveguide has a trapezoidal shape in which the first end portion is an upper base and the second end portion is a lower base.

7. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 1, wherein all of said at least one first optical waveguide are connected to all of said plurality

of expanding width waveguides, respectivelly.

8. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 1, wherein said at least one first optical waveguide comprises a plurality of first optical waveguides at least one of which is connected to said first slab waveguide without interposing said at least one expanding width waveguide.

9. An arrayed waveguide grating optical multiplexer/demultiplexer comprising:

at least one first optical waveguide;

a first slab waveguide;

an arrayed waveguide connected to said at least one first optical waveguide via said first slab waveguide, said arrayed waveguide comprising a plurality of channel waveguides each of which has a different length;

a second slab waveguide;

a plurality of second optical waveguides connected to said arrayed waveguide via said second slab waveguide; and

a plurality of expanding width waveguides each having a third end portion and a fourth end portion, a fourth width of the fourth end portion being larger than a third width of the third end portion, the third end portion of each of said plurality of expanding width waveguides being connected to each of said plurality of second optical waveguides, the fourth end portion being connected to said second slab waveguide, the third width of the third end portion being larger than a second optical waveguide width of each of said plurality of second optical waveguides, the third width of said third end portion satisfying a single mode condition, a width of said expanding width waveguide increasing from the third end portion toward the fourth end portion.

10. An arrayed waveguide grating optical multiplexer/ demultiplexer according to

Claim 9, further comprising:

a plurality of straight waveguides each provided between each of said plurality of second optical waveguides and each of said plurality of expanding width waveguides, each of the said plurality of straight waveguides having a width narrower than the second optical waveguide width of each of said plurality of second optical waveguides.

11. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 9, further comprising:

a plurality of constant width waveguides each provided between each of said plurality of second optical waveguides and each of said plurality of expanding width waveguides, each of said plurality of constant width waveguides having a substantially constant width which is substantially equal to the third width of the third end portion.

12. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 11, further comprising:

a plurality of straight waveguides each provided between each of said plurality of second optical waveguides and each of said plurality of constant width waveguides, each of said plurality of straight waveguides having a width narrower than the second optical waveguide width of each of said plurality of second optical waveguides.

13. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 9, wherein the third width (w) of said third end portion satisfies the following expression,

$$w < \frac{3\lambda}{\pi\sqrt{n_1^{\,2} - n_0^{\,2}}} \quad \text{..... (Exp. 4)}$$

where (n_1) is refractive index of core, (n_0) is refractive index of cladding, and (λ) is a wavelength of light.

14. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 9, wherein each of said plurality of expanding width waveguides has a trapezoidal shape in which the third end portion is an upper base and the fourth end portion is a lower base.

15. An arrayed waveguide grating optical multiplexer/demultiplexer comprising:

at least one first optical waveguide;

a first slab waveguide;

an arrayed waveguide connected to said at least one first optical waveguide via said first slab waveguide, said arrayed waveguide comprising a plurality of channel waveguides each of which has a different length;

a second slab waveguide;

a plurality of second optical waveguides connected to said arrayed waveguide via said second slab waveguide;

at least one first expanding width waveguide having a first end portion and a second end portion, a second width of the second end portion being larger than a first width of the first end portion, the first end portion of each of said at least one first expanding width waveguide being connected to each of said at least one first optical waveguide, the second end portion being connected to said first slab waveguide, the first width of the first end portion being larger than a first optical waveguide width of said at least one first optical waveguide, the first width of said first end portion satisfying a single mode condition, a width of said at least one first expanding width waveguide increasing from the first end portion toward the second end portion; and

a plurality of second expanding width waveguides each having a third end portion and a fourth end portion, a fourth width of the fourth end portion being larger than a third width of the third end portion, the third end portion of each of said plurality of second expanding width

waveguides being connected to each of said plurality of second optical waveguides, the fourth end portion being connected to said second slab waveguide, the third width of the third end portion being larger than a second optical waveguide width of each of said plurality of second optical waveguides, the third width of said third end portion satisfying a single mode condition, a width of said second expanding width waveguide increasing from the third end portion toward the fourth end portion.

16. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 15, further comprising:

at least one first straight waveguide each provided between each of said at least one first optical waveguide and each of said at least one first expanding width waveguide, the at least one first straight waveguide having a width narrower than the first optical waveguide width of said at least one first optical waveguide.

17. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 16, further comprising:

a plurality of second straight waveguides each provided between each of said plurality of second optical waveguides and each of said plurality of second expanding width waveguides, the second straight waveguides each having a width narrower than the second optical waveguide width of each of said plurality of second optical waveguides.

18. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 15, further comprising:

a plurality of second straight waveguides each provided between each of said plurality of second optical waveguides and each of said plurality of second expanding width waveguides, the second straight waveguides each having a width narrower than the second optical waveguide width of each of said plurality of second optical waveguides.

19. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 15, further comprising:

at least one first constant width waveguide each provided between each of said at least one first optical waveguide and each of said at least one first expanding width waveguide, the first constant width waveguide having a substantially constant width which is substantially equal to the first width of the first end portion of said at least one first expanding width waveguide.

20. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 19, further comprising:

at least one first straight waveguide each provided between each of said at least one first optical waveguide and each of said first constant width waveguide, the first straight waveguide having a width narrower than the first optical waveguide width of said at least one first optical waveguide.

21. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 19, further comprising:

a plurality of second constant width waveguides each provided between each of said plurality of second optical waveguides and each of said plurality of expanding width waveguides, each of the second constant width waveguides having a substantially constant width which is substantially equal to the third width of the third end portion.

22. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 21, further comprising:

at least one first straight waveguide each provided between each of said at least one first optical waveguide and each of said at least one first constant width waveguide, the at least one first straight waveguide having a width narrower than the first optical waveguide width of said

at least one first optical waveguide.

23. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 22, further comprising:

a plurality of second straight waveguides each provided between each of said plurality of second optical waveguides and each of said plurality of second constant width waveguide, each of the second straight waveguides having a width narrower than the second optical waveguide width of each of said plurality of second optical waveguides.

24. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 15, further comprising:

a plurality of second constant width waveguides each provided between each of said plurality of second optical waveguides and each of said plurality of second expanding width waveguides, the second constant width waveguides each having a substantially constant width which is substantially equal to the third width of the third end portion.

25. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 24, further comprising:

a plurality of second straight waveguides each provided between each of said plurality of second optical waveguides and each of said plurality of second constant width waveguides, the second straight waveguides each having a width narrower than the second optical waveguide width of each of said plurality of second optical waveguides.

26. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 25, further comprising:

at least one first constant width waveguide each provided between said at least one first optical waveguide and said at least one first expanding width waveguide, the at least one first constant width waveguide having a substantially constant width which is substantially equal to

the first width of the first end portion of said at least one first expanding width waveguide.

27. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 15, wherein the first width (w) of said first end portion satisfies the following expression,

$$w < \frac{3\lambda}{\pi\sqrt{n_1^2 - n_0^2}} \quad \text{... (Exp. 4)}$$

where (n_1) is refractive index of core, (n_0) is refractive index of cladding, and (λ) is a wavelength of light.

28. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 15, wherein the third width (w) of said third end portion satisfies the following expression,

$$w < \frac{3\lambda}{\pi\sqrt{n_1^2 - n_0^2}} \quad \text{..... (Exp. 4)}$$

where (n_1) is refractive index of core, (n_0) is refractive index of cladding, and (λ) is a wavelength of light.

29. An arrayed waveguide grating optical multiplexer/ demultiplexer according to Claim 15, wherein said at least one first expanding width waveguide has a trapezoidal shape in which the first end portion is an upper base and the second end portion is a lower base, and wherein each of said plurality of second expanding width waveguides has a trapezoidal shape in which the third end portion is an upper base and the fourth end portion is a lower base.

30. An expanding width waveguide comprising:

a first end portion; and

a second end portion having a second width larger than a first width of the first end portion, the first end portion being configured to be connected to a first optical waveguide, the second end portion being configured to be connected to a first slab waveguide, the first width

of the first end portion being larger than a first optical waveguide width of the first optical waveguide, the first width of said first end portion satisfying a single mode condition, a width of the expanding width waveguide increasing from the first end portion toward the second end portion.

31. An optical waveguide circuit comprising:

an expanding width waveguide comprising:

a first end portion having a first width and configured to be connected to a single mode waveguide, the first width being larger than a waveguide width of the single mode waveguide and satisfying a single mode condition; and

a second end portion having a second width larger than the first width of the first end portion, a width of the expanding width waveguide increasing from the first end portion toward the second end portion.

32. An optical waveguide circuit according to Claim 31, wherein said expanding width waveguide has a trapezoidal shape in which the first end portion is an upper base and the second end portion is a lower base.